Space Weather Technical Forecast

Issued on Sunday, 08 May 2022 at 01:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Minor geomagnetic storms possible to start and end four days. Decreased risk of radio blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low through the UTC day of Saturday 07 May, with isolated C-class flares recorded at GOES16. The largest of these flares was a C3.6 from AR3006 at 07/0605UTC, but also of note was a C2.2 at 07/1507UTC from a new region arriving over the southeastern horizon. This second group has probably yet to show its full hand due to limb foreshortening, but currently appears as an Hax/Alpha. This spot may have been responsible for a far-sided CME shortly before its arrival on the Earth-facing side, so perhaps remains a region to monitor.

There are currently up to five sunspot regions on the disc, with AR3004 and AR3006 still dominant in terms of their flare risk on paper, although there has been a definite settling in activity as they have matured over the past 36 hours. AR3004 showed a decline in its overall size, with consolidation and fading of its intermediate and trailing spots, with its Mt Wilson delta spot now very tenuous immediately east of the large leading group. AR3006 was more active, with numerous small spots covering sufficient span on the disc to warrant classification as a Zurich E-group, however its delta is now also very faint. All other regions on the disc were unremarkable, including a stable Hsx/Alpha in the form of AR3001, a small Axx group to its northeast, and the aforementioned new region in the southeast.

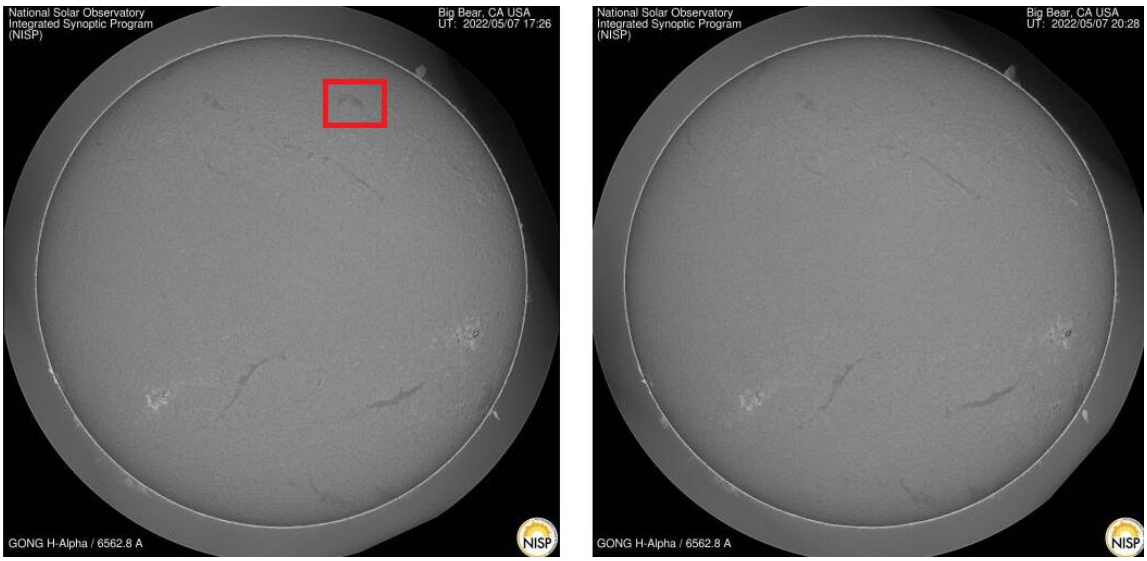

Figure 0: H-Alpha imagery showing a disappearing filament in the period. Coronagraph imagery is awaited.

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There remain a large number of filaments on the disc at present, one of which was seen to disappear around 07/1900UTC. This event has yet to manifest in coronagraph imagery but is awaited. In addition, shortly before the start of this 24-hour reporting period, a filament lift-off occurred in the northeastern quadrant (around 06/1900UTC). This was seen in subsequent coronagraph imagery and has been analysed with a possible Earth-bound component, perhaps due late on 10 May. No other Coronal Mass Ejections (CMEs) were in evidence in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1 followed a slow regime between 300-400 km/s. The solar wind density was similarly unremarkable in low single-figures ppcc, while the IMF was steady at or below 6nT, albeit with a mostly anti-aligned (with Earth's field) north-south component of -5/+1nT. The phi angle remained steadfastly negative (towards the Sun). Resulting geomagnetic activity was Quiet throughout (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at Background levels through the last 24 hours.

The high energy electron flux has varied between Moderate and High levels, reaching a peak of 1410pfu at 07/1620UTC. Electron fluence was steady, with the 24-hour integrated observed value at 08/0001UTC being 6.69e7pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: A quietening trend in the most active groups should mean activity should be mostly Low, but with a daily Chance of M-class flares and a Slight Chance of X. This risk should reduce slightly with the passing of one of the largest spots onto the far side by midweek UTC.

Solar Wind / Geomagnetic Activity: No significant coronal holes feature in this forecast.

Up to two CMEs are possible in the period, firstly a low confidence arrival from 03/1700UTC due within day one, Sunday 07 May, although this feature is now later than anticipated with a reduction in the risk of G1 therefore suggested. After a lull on Monday, there is then a period of more likely G1 intervals from a second CME, spawned by a disappearing filament on 06/1900UTC. This risk should peak shortly after the most likely arrival time of 10/1500UTC, probably then continuing into day four before abating.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is at Background levels, with a daily Slight Chance of S1 largely as a result of AR3004's westward advance.

The high energy electron flux (greater than 2MeV) is forecast to remain at predominantly Moderate levels, but could reach the High threshold (1000 pfu) at the peak of its diurnal oscillation. A decline in the flux is expected through the four days, especially if geomagnetic activity increases with CME arrival(s). 24-hour fluence is now Expected to remain below the Active threshold.

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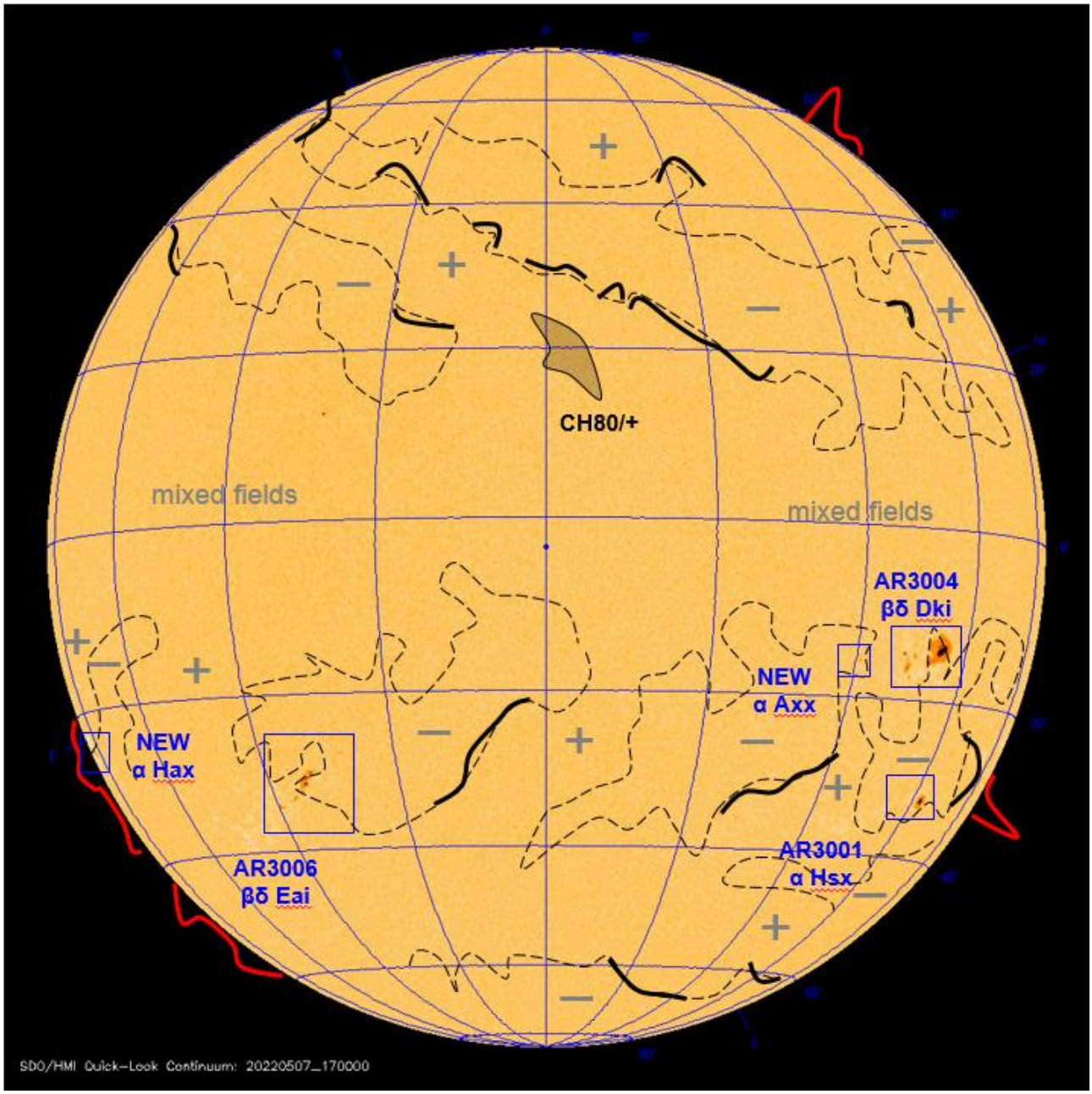
Figure 1. Solar Analysis Valid 07/1700UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one small non-persistent coronal hole on the disc at present, the small CH80/+ in the northern solar hemisphere. Any resultant high speed stream has yet to manifest at STEREO A. This means any Earth-based effect is either at least 2.5 days away, or the effects have been swamped, as the satellite appears to have its recent measurements polluted by a CME. This may be the 03 May 1700UTC event that may also affect Earth as a glance during day one, Sunday 08 May to give a Slight Chance of G1. The effect of the coronal hole at Earth is likely to be minimal, and will probably be indistinct due to a second CME arrival due later on day three, Tuesday 10 May and continuing on into Wednesday 11 May. This CME emanated from a northeast quadrant filament lift off on 06/1900UTC and is a higher confidence arrival, probably straddling the final two days of the period, with a most likely arrival time of 10/1500UTC.

The most reliably quiet day geomagnetically is therefore day two, Monday 09 May, with a risk of G1 to start and end the four days from up to two transients.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	30	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/0552	Partial	Vicinity of AR3004	NE Quadrant	407km/s	Early 08 May	Overdue, low confidence
07/0700	Partial	Filament	NE Quadrant	581km/s	10/1500UTC	Higher confidence

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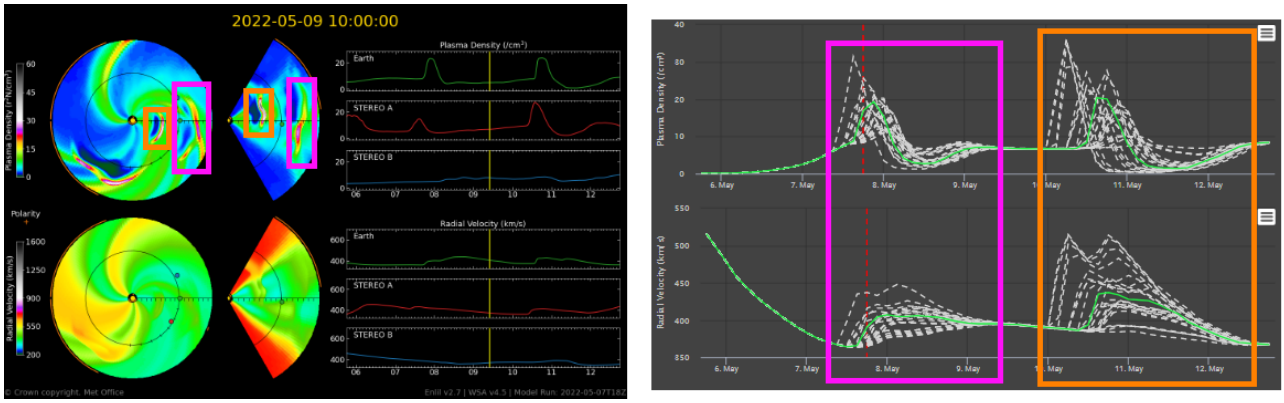
Figure 2: Latest MOSWOC Enlil and ensemble, showing 03/1700UTC CME (boxed magenta) and the 06/1900UTC CME boxed orange.



Radio Blackouts - X-Ray Flares:

There are up to five sunspot regions on the disc at present. AR3006 and AR3004 remain the groups to watch, although the trend in their growth and activity has been down over the past 36 hours or so. Both of these groups have Mt Wilson delta spots that are both now tenuous, perhaps going some way to explaining their increasingly quiet behaviour.

Making up the rest of the front side, a third numbered group - the stable and simple AR3001 - remains a unipolar Hsx. As well as this unipolar region, a small unnumnbered spot developed and faded to its northeast, finishing the 24 hours an Axx Alpha. Over on the eastern solar horizon, a new group has rotated onto the disc, which is currently showing as at least an Hax Alpha, however further detail is likely to reveal itself over the coming day, with any estimate of flare risk probably underdone from this region.

All considered, there is a daily Chance of M-class flares, reduced compared to recent days in line with observations at GOES16. This risk should further diminish as AR3004 rotates off the disc into day four, Wednesday 11 May. STEREO A EUVI 195 imagery hints at a northern solar hemisphere bright flux region near 110E, with this therefore due on Monday 09 May, however any increased risk from this area will be assessed when it presents for analysis.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	25	25	10	10
Very Active	R3 to R5 X Class	No	5	5	2	2

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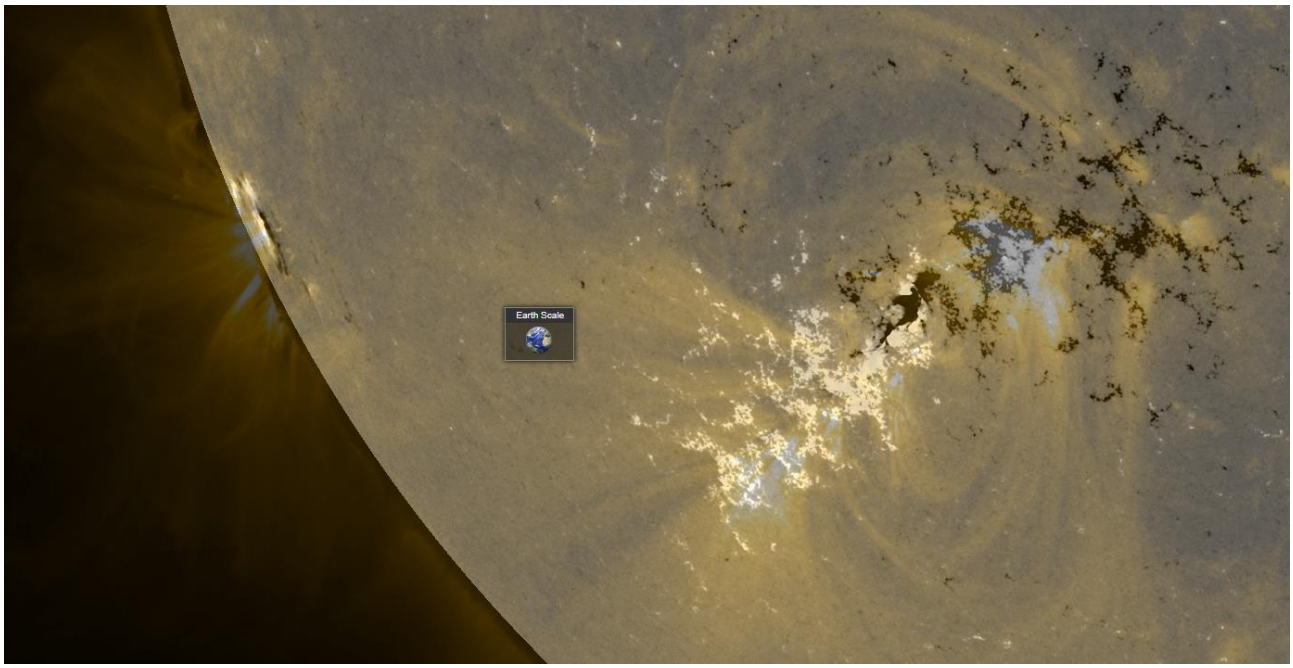
Figure 3: Composite image from 07/2200UTC of HMIB and AIA171, showing AR3006 (right) and an emerging new region near the eastern solar horizon. These groups were responsible for the largest flares of the past 24 hours. Image processing courtesy of helioviewer.org.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at Background levels, and is most likely to remain so through the next four days.

There is a daily Slight Chance of S1 due to AR3004's approach towards the western limb over the forecast period, and despite some M-class flares, it does not have a history of producing any proton response at GOES16.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) is forecast to be mainly Moderate, perhaps reaching High levels in its diurnal oscillation. A gradual decline in fluence is otherwise expected through the period in the unsupportive current solar wind environment.

The likelihood for Active fluence (1e8 integrated flux) levels to be reached should reduce with time, especially with potential significant geomagnetic activity occurring in the wake of any

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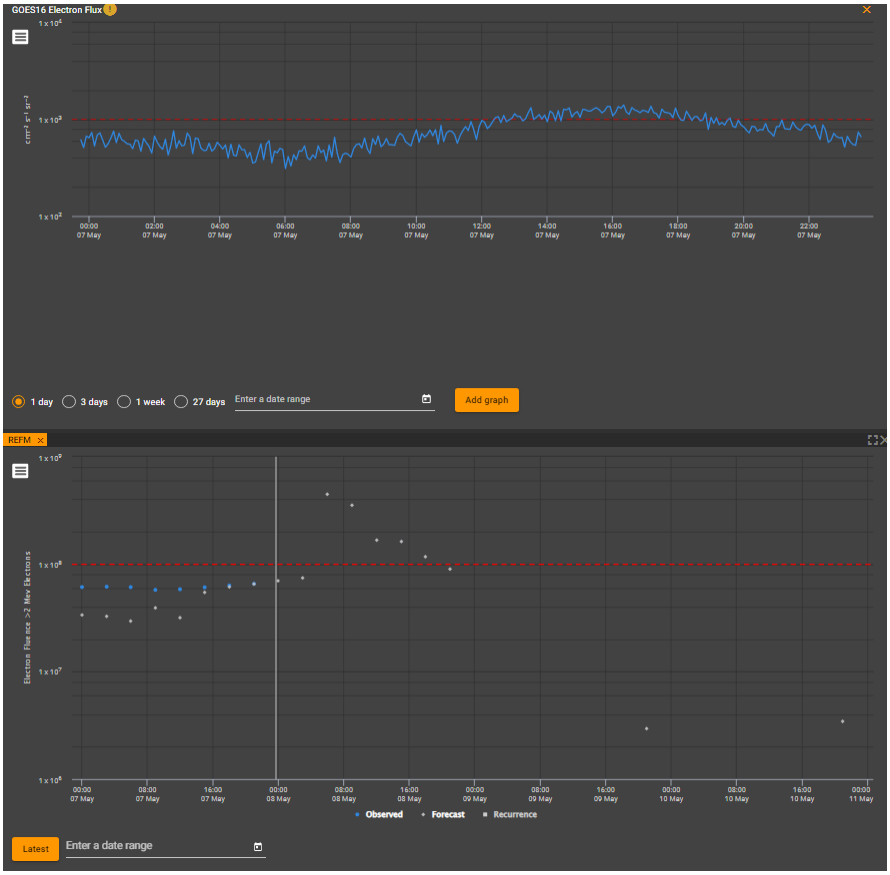
CMEs. Output from the Met Office REFM is therefore considered to be offering good guidance in keeping the fluence below the Active threshold, combined with a declining trend.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	5	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Past 24 hours electron flux at GOES16 (top) and observed fluence (bottom, blue dots). Also shown is REFM forecast (grey dots), with persistence trend omitted for lack of similarity in forecast coronal holes on this occasion, as well as the presence of up to two CMEs.



NOTE: Our REFM model has been upgraded and has changed in appearance. The two main changes are the option to include a recurrence graph (turned off on the above plot), which superimposes observations from the last solar rotation onto the current solar rotation (each plot is the observation from T-minus 28 days). Recurrence is used as a guide to what can be expected in the coming days assuming no difference in solar features, and has low accuracy in certain situations but good accuracy in others (such as recurring coronal holes). The other change is the cadence of REFM forecast fluence data has been reduced past day 1 to only one value per day. The cadence remains 3-hourly for the first 24 hours.

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